Implementing Cisco IP Routing (ROUTE)

Foundation Learning Guide

CCNP ROUTE 300-101

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```
172.16.12.2     2.2.2.2         587         0x80000003 0x00A5B6

                Summary Net Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum
172.16.13.0     1.1.1.1         403         0x80000007 0x009CC5
172.16.14.0     1.1.1.1         403         0x80000007 0x0091CF
192.168.1.0     1.1.1.1         403         0x80000002 0x00B616

                Summary ASB Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum
3.3.3.3         1.1.1.1         1143        0x80000002 0x0035EB

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
10.0.0.0        3.3.3.3         1089        0x80000002 0x000980 0
```

OSPF type 1 LSAs are exchanged only within OSPF areas. Router R2, which has interfaces that are configured in OSPF area 1, should not see any type 1 LSAs that were originated on R4. The output of the OSPF database from R2 confirms this. No type 1 LSA with the advertising router parameter set to 4.4.4.4 can be found in the LSDB.

Example 3-30 displays the LSAs on R1.

Example 3-30 *R1's OSPF LSDB*

```
R1# show ip ospf database

            OSPF Router with ID (1.1.1.1) (Process ID 1)

                Router Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         445         0x8000000B 0x00966C 2
4.4.4.4         4.4.4.4         103         0x80000008 0x001A4F 1
<Output omitted>
                Router Link States (Area 1)
Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         445         0x80000008 0x0097B7 1
2.2.2.2         2.2.2.2         1133        0x80000008 0x006E5C 2
 <Output omitted>
                Router Link States (Area 2)
Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         445         0x80000008 0x00DDA5 1
3.3.3.3         3.3.3.3         1131        0x8000000A 0x00521D 1
 <Output omitted>
```

Notice that router R1 is the only router that is in multiple areas. As an ABR, its OSPF database includes type 1 LSAs from all three areas.

OSPF Type 2 Network LSA

Figure 3-13 shows a type 2 LSA, which is generated for every transit broadcast or NBMA network within an area.

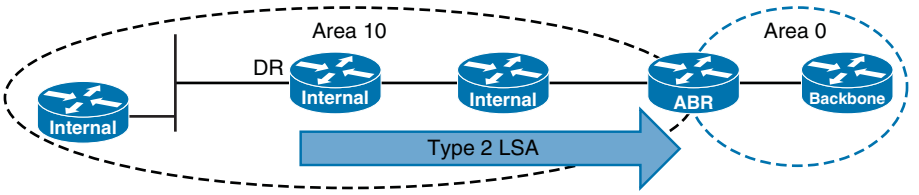

Figure 3-13 *OSPF Type 2 LSA*

The DR of the network is responsible for advertising the network LSA. A type 2 network LSA lists each of the attached routers that make up the transit network, including the DR itself, and the subnet mask that is used on the link. The type 2 LSA then floods to all routers within the transit network area. Type 2 LSAs never cross an area boundary. The link-state ID for a network LSA is the IP interface address of the DR that advertises it.

Example 3-31 shows R4's OSPF LSDB with a focus on the type 2 LSAs.

Example 3-31 *R4's Type 2 LSAs*

```
R4# show ip ospf database

            OSPF Router with ID (4.4.4.4) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         486         0x8000000B 0x00966C 2
4.4.4.4         4.4.4.4         142         0x80000008 0x001A4F 1

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.16.14.2     4.4.4.4         142         0x80000007 0x008FB6
<Output omitted>
```

Notice that R4 has only one type 2 LSA in its LSDB. This is expected because there is only one multiaccess network in area 0.

Example 3-32 shows the details of a type 2 LSA on router R4.

Example 3-32 *R4's Type 2 LSA Details*

```
R4# show ip ospf database network

            OSPF Router with ID (4.4.4.4) (Process ID 1)

                Net Link States (Area 0)

  Routing Bit Set on this LSA in topology Base with MTID 0
  LS age: 170
  Options: (No TOS-capability, DC)
  LS Type: Network Links
  Link State ID: 172.16.14.2 (address of Designated Router)
  Advertising Router: 4.4.4.4
  LS Seq Number: 80000007
  Checksum: 0x8FB6
  Length: 32
  Network Mask: /30
        Attached Router: 4.4.4.4
        Attached Router: 1.1.1.1
```

The content of the displayed type 2 LSA describes the network segment listing the DR address, the attached routers, and the used subnet mask. This information is used by each router participating in OSPF to build the exact picture of the described multiaccess segment, which cannot be fully described with just type 1 LSAs.

OSPF Type 3 Summary LSA

ABRs do not forward type 1 and 2 LSAs between areas to improve OSPF scalability. However, other routers still need to learn how to reach interarea subnets in other areas. OSPF advertises these subnets on ABRs by using type 3 summary LSAs, as shown in Figure 3-14.

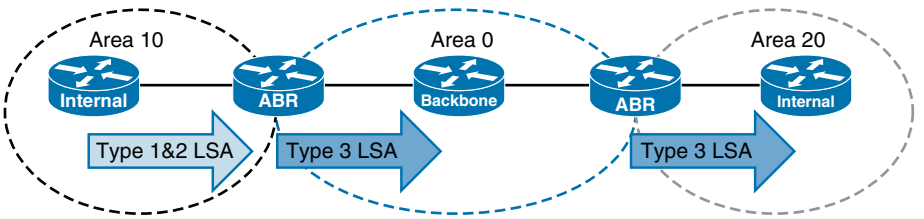

Figure 3-14 *OSPF Type 3 LSA*

The ABRs generate type 3 summary LSAs to describe any networks that are owned by an area to the rest of the areas in the OSPF autonomous system, as shown in the figure.

Summary LSAs are flooded throughout a single area only, but are regenerated by ABRs to flood into other areas.

Notice that the figure only illustrates how information is propagated from area 10 to the other areas. Type 3 LSAs are also advertised by ABRs in other direction, from area 20 to area 0, and from area 0 into area 10.

By default, OSPF does not automatically summarize groups of contiguous subnets. OSPF does not summarize a network to its classful boundary. A type 3 LSA is advertised into the backbone area for every subnet that is defined in the originating area, which can cause flooding problems in larger networks.

As a best practice, you can use manual route summarization on ABRs to limit the amount of information that is exchanged between the areas.

Example 3-33 displays R4's OSPF LSDB, with the focus on type 3 LSAs.

Example 3-33 *R4's Type 3 LSAs*

```
R4# show ip ospf database

            OSPF Router with ID (4.4.4.4) (Process ID 1)

                Router Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         583         0x8000000B 0x00966C 2
4.4.4.4         4.4.4.4         238         0x80000008 0x001A4F 1
                Net Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum
172.16.14.2     4.4.4.4         238         0x80000007 0x008FB6
                Summary Net Link States (Area 0)
Link ID         ADV Router      Age         Seq#       Checksum
172.16.12.0     1.1.1.1         583         0x80000007 0x00C567
172.16.13.0     1.1.1.1         583         0x80000007 0x009CC5
192.168.2.0     1.1.1.1         1322        0x80000002 0x002E5D
<Output omitted>
```

The LSDB on router R4 includes three different type 3 summary LSAs, all advertised into area 1 by the ABR R1.

Example 3-34 shows the details of R4's type 3 LSAs.

Example 3-34 *R4's Type 3 LSA Details*

```
R4# show ip ospf database summary

            OSPF Router with ID (4.4.4.4) (Process ID 1)

                Summary Net Link States (Area 0)

  Routing Bit Set on this LSA in topology Base with MTID 0
```

```
LS age: 608
Options: (No TOS-capability, DC, Upward)
LS Type: Summary Links(Network)
Link State ID: 172.16.12.0 (summary Network Number)
Advertising Router: 1.1.1.1
LS Seq Number: 80000007
Checksum: 0xC567
Length: 28
Network Mask: /30
      MTID: 0         Metric: 64

Routing Bit Set on this LSA in topology Base with MTID 0
LS age: 608
Options: (No TOS-capability, DC, Upward)
LS Type: Summary Links(Network)
Link State ID: 172.16.13.0 (summary Network Number)
Advertising Router: 1.1.1.1
LS Seq Number: 80000007
Checksum: 0x9CC5
Length: 28
Network Mask: /30
      MTID: 0         Metric: 10

Routing Bit Set on this LSA in topology Base with MTID 0
LS age: 1348
Options: (No TOS-capability, DC, Upward)
LS Type: Summary Links(Network)
Link State ID: 192.168.2.0 (summary Network Number)
Advertising Router: 1.1.1.1
LS Seq Number: 80000002
Checksum: 0x2E5D
Length: 28
Network Mask: /24
      MTID: 0         Metric: 65
```

The output in the examples shows detailed information about three type 3 LSAs in the LSDB. Each type 3 LSA has a link-state ID field, which carries the network address, and together with the attached subnet mask describes the interarea network. Notice that all three LSAs were advertised by the router having router ID set to 1.1.1.1, which is the ABR router R1.

OSPF Type 4 ASBR Summary LSA

Figure 3-15 shows a type 4 summary LSA generated by an ABR only when an ASBR exists within an area. A type 4 LSA identifies the ASBR and provides a route to the

ASBR. The link-state ID is set to the ASBR router ID. All traffic that is destined to an external autonomous system requires routing table knowledge of the ASBR that originated the external routes.

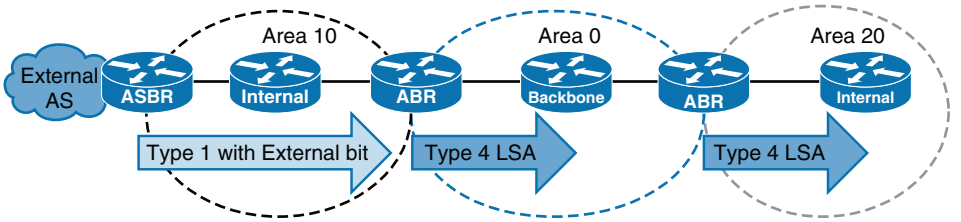

Figure 3-15 *OSPF Type 4 LSA*

In the figure, the ASBR sends a type 1 router LSA with a bit (known as the *external bit*) that is set to identify itself as an ASBR. When the ABR (identified with the border bit in the router LSA) receives this type 1 LSA, it builds a type 4 LSA and floods it to the backbone, area 0. Subsequent ABRs regenerate a type 4 LSA to flood it into their areas.

Example 3-35 shows R4's OSPF LSDB with a focus on type 4 LSAs.

Example 3-35 *R4's Type 4 LSAs*

```
R4# show ip ospf database

            OSPF Router with ID (4.4.4.4) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         666         0x8000000B 0x00966C 2
4.4.4.4         4.4.4.4         321         0x80000008 0x001A4F 1

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.16.14.2     4.4.4.4         321         0x80000007 0x008FB6

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
172.16.12.0     1.1.1.1         666         0x80000007 0x00C567
172.16.13.0     1.1.1.1         666         0x80000007 0x009CC5
192.168.2.0     1.1.1.1         1405        0x80000002 0x002E5D

                Summary ASB Link States (Area 0)
```